A 4D Flight Profile Server And Probability-Based 4D Weather Objects

Toward a Common Core Toolset for the NAS

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Two Types of ASD Tools

TFM and AOC oriented

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Gov't entities (NASA, MITRE, Volpe) are developing ASD tools for TFM

Commercial vendors, as well as some airlines, are developing their own Air Situation Display (ASD) tools for AOCs

The two types of tools have a <u>different</u> mission

- Primary users for TFM ASD tools are traffic flow managers.
- Primary users for AOC ASD tools are airline dispatchers.
- TFM ASD deals with traffic flows involving hundreds of aircraft …
- A dispatcher's ASD should be intimately connected to the AOC's "internal world"
  - concentrating on each *individual* flight, its route, fuel, crews, pax, maintenance etc.

AOC tools and TFM tools use different algorithms, different weather products, sometimes inconsistent traffic data

This makes collaborative process, and its automation, more difficult

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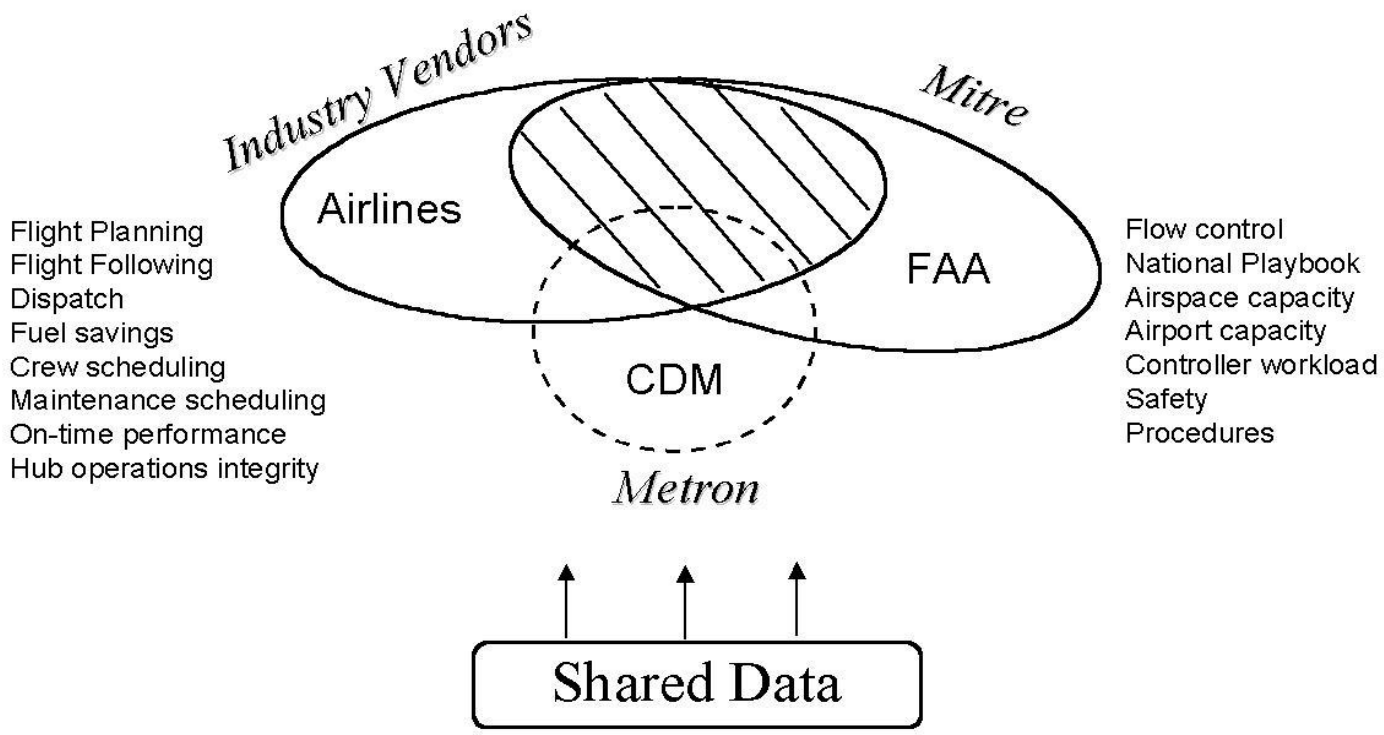
Overlapping Tool Functions

The government is not in the business of building AOC tools…

…while AOC vendors are not building TFM tools for the FAA.

These tools, while different, have a considerable overlap. Example:



Common Core

Tools and Capabilities for Collaborative TFM

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Government and airline tool vendors ought to work together on a *common core* of operational data and tools/components:

- TFM user application
- AOC user application
- Shared data
- Common (or different-but-calibrated) algorithms
- Common GUI look-and-feel but application specific functions
- XML based communication, messaging, alerts

Ideally, each user should have a *single* display integrating the functions required for this type of user

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Common Core Categories

The categories that belong to the Common Core are the following:

- DATA
- ALGORITHMS
- PRESENTATION / GUI
- COMMUNICATIONS

The Common Core tools should

- use the same *data*;
- utilize the same basic *algorithms* for aircraft movement related calculations;
- have a consistent *presentation / GUI* style for various users; and
- be able to *communicate* seamlessly.

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Common Core Algorithm Library

The concept would call for creating a shared library of algorithms.

Algorithms developed by industry would be made public (Open Source) if their development was paid for by the Gov't;

OR

Rolled into library modules (binary – no source code disclosure) that are thoroughly documented / validated and their APIs published;

OR

If the algorithms remain different for each application, they would be calibrated using same or compatible set of data

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Standards and Guidelines

Data sources, algorithms, messages and presentation / GUI would form a set of standards and guidelines

- with multiple choices where appropriate

These standards would be sanctioned by the stakeholders (FAA, DoT, airlines, vendors), and the current/future tool components would be expected to adhere to them

The standards could be expandable, including possibly non-US air traffic systems

The natural starting point for standardization would be data

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Common Core Toolset

Some Elements and Concepts

We will now discuss some specific concepts:

- 4D Flight Profile Server
- Probability-Based 4D Weather Objects
- Predictive Management with Fast-Forwarding

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4D Flight Profile Server

Concept

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Create a 4D flight profile server for the NAS (NAS 4DFP)

- To be used by both TFM and AOC tools NAS-wide
- To be built on the Common Core concept using common NAS data, calibrated & validated algorithms
- Would use a common fast-access database
- Asynchronous access, frequent updates for up-to-the-minute status
- To provide up-to-the-minute 4DFP information for any client: a TFM tool, an AOC dispatch tool, a security console
- Instantaneous traffic forecast, combined with weather forecast, for predictive management
- Fast-forwarding in any client application, instantly

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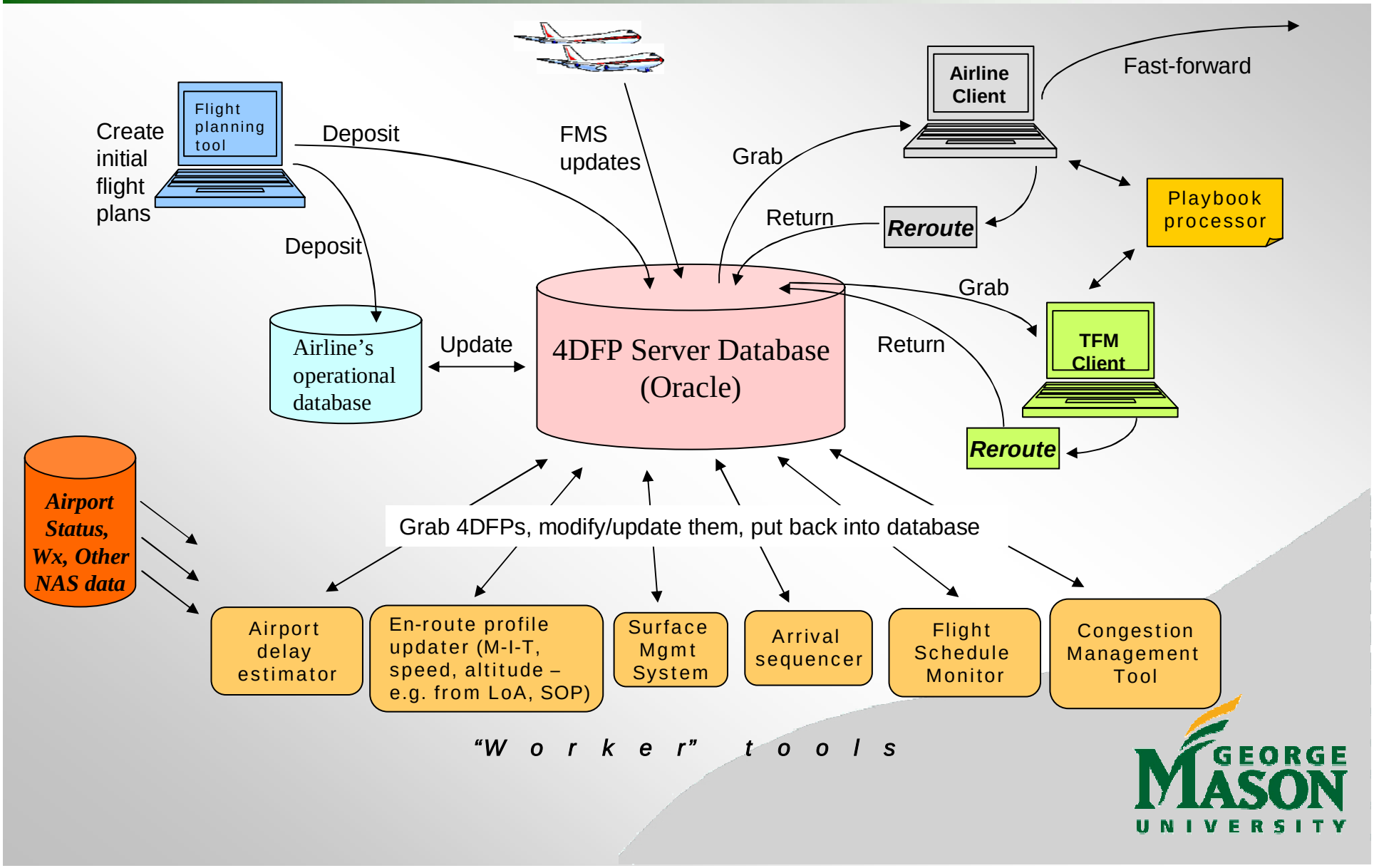
4D Flight Profile Server

Diagram



Probability Based Weather

"Fuzzy" Objects

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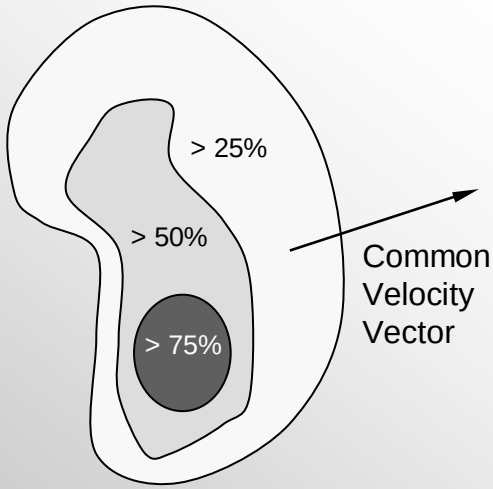
CCAs = Capacity Constrained Areas

- Represent static or moving weather / other hazard / constraint areas
- Can be generated automatically from ingested data, or drawn manually
- Are "solid 100% probable" objects moving along constant velocity vector

"Fuzzy CCAs" - an evolution of the CCFP concept

- Would include probabilities, growth/shrink option and curved paths – better representing complex severe weather systems, hurricanes, typhoons etc
- Aircraft can be rerouted around CAA "family" components with probability > X%



The three objects on this drawing represent a single severe weather cell whose movement follows the same velocity vector.

Note that the outer polygons have no "holes" (formed by inner polygons): they are contiguous filled objects. Inner and outer polygons simply overlap, forming a family with different upper and lower boundaries.

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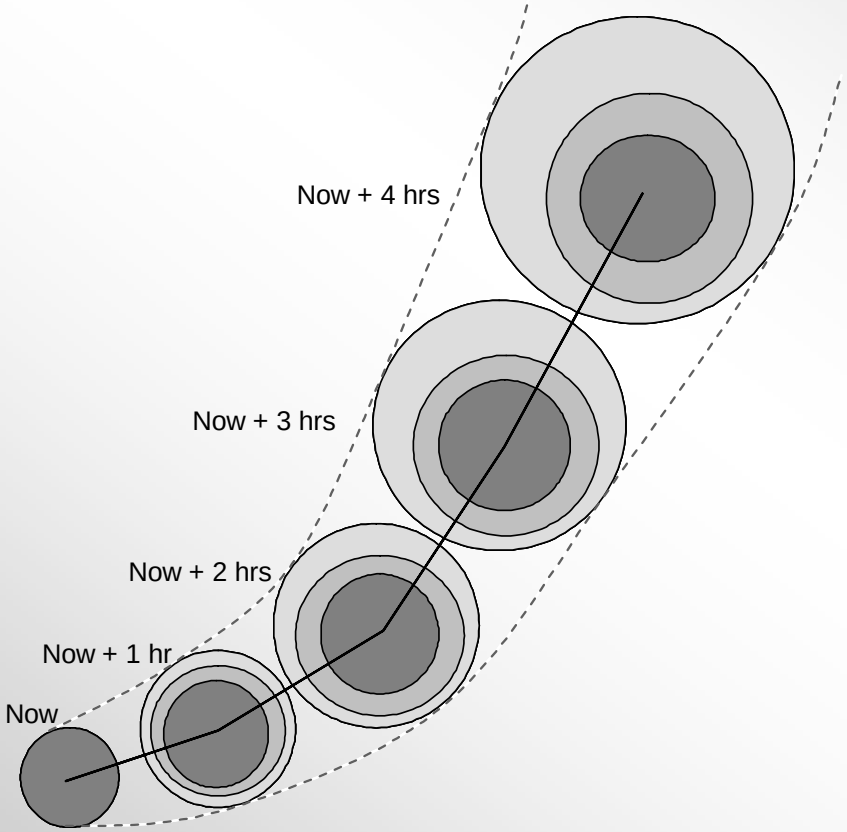
Probability Based Weather

Example: Hurricane Depiction



Hurricane speed is exaggerated for illustration purposes

Centroid of 4D object family is a polyline

Object area growth reflects uncertainty

Aircraft can penetrate or avoid each concentric zone depending on perceived intensity/probability

Disruption Management

Predictive Management + CDM = Better Decisions

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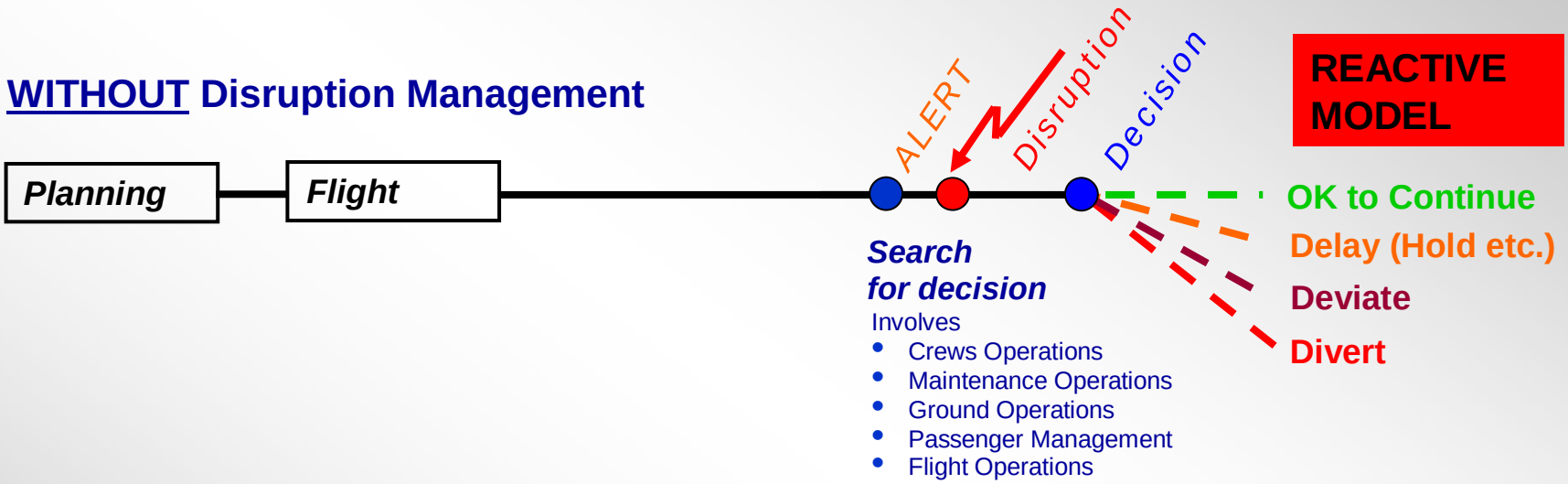

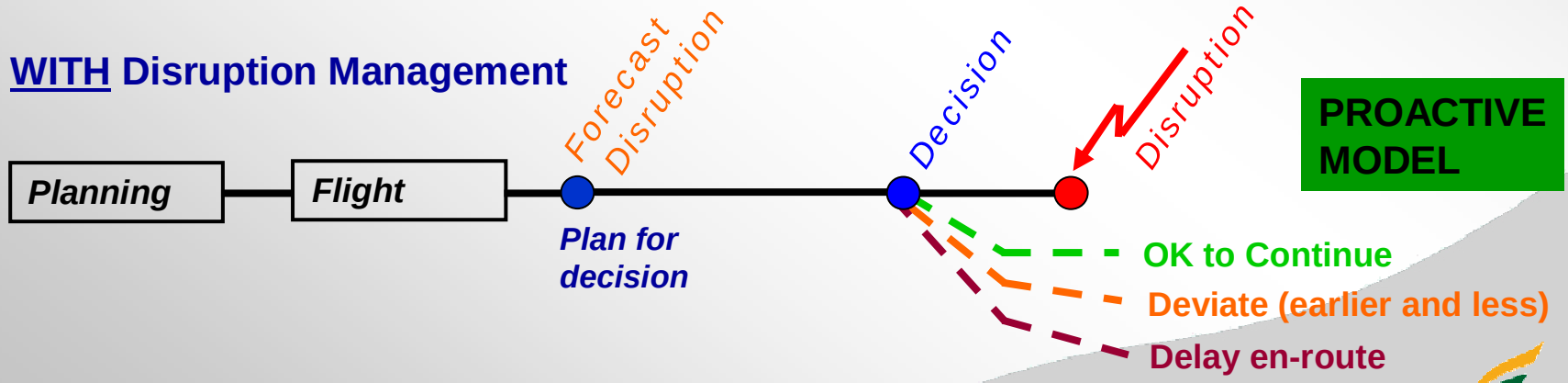

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Back-Up Slides

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Possible Common Core Data Types

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"Static", such as:

Airspace
- boundaries
- procedures (LoA, SOP,...)
- SUA / MOA

Capacities
- Monitor Alert parameters
- Airport capacity numbers

Routing Information
- Waypoints, airways, fixes
- SIDs, STARs
- Preferential routes
- Nat'l Playbook, CDRs

Aircraft Performance
- Performance data

Airports
- Runway layouts

Dynamic, such as:

Winds, Temperature, Pressure

Weather [*define products!]*
- Radar weather, Turbulence, Icing etc
- Forecasts including 4D objects

Traffic
- Flight plans
- Track data

Capacities
- Airports (current / forecast, IFR/VFR)
  - Runway configuration
  - Arrival/Departure rates
- Airspace

Active Procedures
- Pref. Routes
- CDRs/Playbook scenarios
- SUA/MOA
- Flow/Capacity Constrained Areas (F/CCA)
- Ground Stop / Ground Delay Programs
- Miles-in-Trail restrictions

Sector/Airspace Configuration

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Possible Common Core Algorithms

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- Aircraft performance model
- 4D flight profile calculation
- Route conversion (waypoint/airway/SID/STAR/etc to LatLong sequence)
- Meteorological data usage (wind/temperature/pressure effects)
- 4D Intersection of flights and:
  - airspace objects (sectors, SUA); FCA/CCA; routes/fixes
- Delay calculations for capacity constrained resources
  - estimating current delays; predicting; selecting actions
- Airport activity prediction
  - runway configuration changes; runway selection; SID/STAR selection
- Sequencing (prediction, sequencing slot and interval calculation)
- Route rejoin rules (when an aircraft has deviated)
- Rerouting algorithms
- Terminal area flight algorithms (within TRACON)
  - radar vectoring; holding; speed control
- Ration-by-schedule / substitutions
- Other collaborative algorithms

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